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REMARKS/ARGUMENTS

Reconsideration of this application is respectfully requested in view of the foregoing amendments and discussion presented herein.

1. Rejection of Claim 1 for informalities.

Claim 1 was rejected as it was pointed out that the phrase "*said illumination detector*" in line 8 lacked proper antecedent basis.

Claim 1 was amended to positively recite the illumination detector.

2. Rejection of Claims 2 and 23 under 35 U.S.C. §112, second paragraph.

Claims 2 and 23 were rejected under 35 U.S.C. §112, second paragraph as being indefinite.

In Claims 2 and 23 the Examiner found the phrase "*small thermoreflectance*" to be indefinite as no standard exists for defining the what a "small" degree of thermoreflectance is.

Claims 2 and 23 have been amended to eliminate the word "small". It should be appreciated, however, that one of ordinary skill in the art would expect "small" values of thermoreflectance to be in the range of 10^{-6} to 10^{-3} per degree centigrade for most common materials.

3. Rejection of Claims 1-12, 17, 19, 21, 23-26, 40 and 42-43 under 35 U.S.C. § 102(b).

Claims 1-12, 17, 19, 21, 23-26, 40 and 42-43 were rejected under 35 U.S.C. § 102(b) as being anticipated by Hutchinson (U.S. No. 5,751,830).

After carefully considering the grounds for rejection the Applicant responds as follows.

The primary reference, Hutchinson, describes a "*Method and Apparatus for Coherent Imaging of Infrared Energy*". Although it may be said that Hutchinson describes one form of thermal imaging, there are a number of distinctions between Hutchinson and the claims of the present invention.

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At the outset it should be understood that Hutchinson describes a system for quantizing infrared emissivity of objects, to determine the amplitude, phase, and frequency distribution of the detected radiation (see Technical Field, and Abstract of Hutchinson). The object of Hutchinson, as brought out at the outset of the Summary of the Invention (see col. 2, line 66 through col. 3, line 3), is given as follows: "*Thus there is a need for a single camera system which performs ranging, spectroscopy, and thermal imaging without the disadvantage of having to mechanically scan, and one with the versatility to operate in either a passive mode or active mode.*" Applicant's approach for thermal imaging is quite distinct from the imaging system of Hutchinson which combines light received from the object with light received from a modulated light source.

In the case of coherent imaging of Hutchinson, the detector locks-in to the frequency of the light emanating from the object by mixing it with a modulated light source from a local laser oscillator (refer to column 3, lines 23-35). The detector receives the combined energy of the two light sources, often with the help of a beamsplitter (refer to column 3, lines 23-35). The detector oscillates at very high frequencies (GHz) and by performing lock-in detection of the AC component, one can get the amplitude and the phase of radiation emitted by an object. This can be used to do thermal imaging of static objects, wherein their temperature does not vary with time during the lock-in process. However, this process requires the system to be calibrated for emissivity and resolution is limited by the emitted infrared wavelength (i.e., several microns). Since the Hutchinson system is directed at macro scale sensing, such as associated with applications in air-pollution studies, atmospheric disturbance monitoring, and military weapons monitoring (the applications described in the Abstract and body of the specification), the lack of resolution should not pose a hindrance to that object.

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In contrast, the approach taught and claimed by the Applicant is directed to different objects and operates according to different operating principles. The object of Applicant's system is not directed at registering light emitted by the target to perform combinations of ranging, spectroscopy and macro scale thermal imaging. Applicant's invention is directed at generating high resolution thermal imaging of objects. These distinctions are made clear by the fact that Applicant's system does not combine two light sources, and uses only one light source which is incident on the sample. There is no requirement to modulate the light source. Further, the processing performed by Applicant's system need not generate an intermediate optical frequency signal having a voltage component and frequency component. In applicant's approach the infrared emissivity is not measured, but the change in the reflection coefficient of the sample in response to temperature modulations. Since visible or shorter wavelength light incident on the sample is used, temperature can be easily measured with submicron spatial resolution. (Hutchinson is directed at long wavelength infrared light.)

In the claims of the instant application the temperature of the sample must is actively modulated (e.g., by modulating current through the device), which is not an aspect taught by Hutchinson. The lock-in detector array detects the amplitude and the phase of this AC modulation (typically in Hz-kHz frequency range) and from this we can get the temperature "variations" (heating by the device). Note that the processing of the reflectance information is not the complex intermediate frequency process taught by Hutchinson, while the result and objects also differ.

The claims of the instant application reflect these distinctions and are not anticipated or obvious in view of the cited references. Discussion relating to the specific claims of the instant Application follow.

(a) Claim 1. Claim 1 is an independent claim drawn to an apparatus for providing non-contact thermal measurements at high spatial and thermal resolutions.

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In support of the rejection of Claim 1, the Examiner indicates that Hutchinson is drawn to the same objects of invention, for example the high spacial and thermal resolution. However, the nature and resolutions of the systems are clearly different. In the passage put forth in support of high resolution, Hutchinson is speaking about imaging a cloud in an air pollution study, it is certain that is cloud is well beyond a one micron size as discussed by the Applicant. In addition, as discussed above, the technique of Hutchinson can not provide a resolution which is any better than the length of the infrared light sources being used, although this is not a problem in view of the applications for Hutchinson it is not workable for performing the submicron circuit work dealt with by the Applicant. The Applicant, however, describes testing circuit element objects and features which can be smaller than one micron.

Getting into the body of Claim 1, there are a number of aspects of original Claim 1 that do no comport with the teachings of the Hutchinson reference.

The illumination source is described in the claim, but there is no discussion as to how that illumination source is to be modulated; because there is no need for modulation of the light source as there is in the Hutchinson reference. Referring to Fig. 8 of Hutchinson, it is seen that chopper 304 modulates the laser input which is combined with the emissions of black body 302 as described in column 9, lines 36-41. The modulation of the light source is addressed throughout Hutchinson as it is required to enable this technique, refer also to column 3, lines 27-29, where a local oscillator laser is referred to. The applicant provides no discussion of the need of modulating the illumination source, or other means which operate by combining multiple emission sources.

In support of the rejection of "*means for generating a bandwidth-limited AC-component of the signal from said illumination detector while said object is subjected to modulated thermal excitation*", Column 9, line 52 through column 10, line 10 of Hutchinson are put forth. As can be seen below, this section of Hutchinson provides no

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support for modulated thermal excitation.

> *"With continued reference to FIG. 8, energy provided by a waveguide CO.sub.2 laser 312 is combined by means of a beamsplitter 310 with the energy being alternately provided by the blackbody/chopper configuration so that heterodyne detection occurs at the photodetector 58. The resultant IF signal contains two components: an ac component representative of the alternating chopper energy received, and a dc component representative of noise in the system. Typically, the dc noise signal will have a much greater magnitude than the ac signal. The IF signal, with its dc and ac components, is amplified and rectified by the IF receiver channel 200 to produce a measurable dc voltage 314 representative of the system noise. To extract the ac component, a lock-in amplifier 318 is used to isolate the ac component and then amplifies it to a measurable level. The lock-in amp 318 knows the frequency of the chopper 304 and looks for an oscillation in the IF signal that has the same frequency. Once the lock-in amp 318 finds a matching oscillation, the oscillation is amplified to produce an ac voltage signal 316. The isolated ac and dc components are compared and the bias tee 202 is adjusted by dc bias signal 214 to optimize the system's signal (ac component) to noise (dc component) ratio. This process is repeated for each photodetector 58 in the focal plane array 20. Very good photodetectors 58 with high quantum efficiencies will often provide a strong enough ac component to preclude the need for a lock-in amp 318."*

Hutchinson beats the modulated light emissions with the emissions from the source to generate the intermediate frequencies. Hutchinson in no way is configured for modulating the thermal excitation of the source, nor could this be done in view of the embodiments, objects of the Hutchinson invention, and the materials being imaged.

It is well settled that for anticipation under 35 USC 102, the anticipating reference must show all the elements of the claim. As the apparatus of Hutchinson does not include the use of modulated thermal excitation, requires the use of a modulated illumination source, and requires structures for combining multiple light sources which are not recited in Claim 1, it is thus improperly applied against Claim 1 and its progeny. Accordingly, Hutchinson does not teach the elements recited in Applicant's Claims 1, and does not anticipate this claim.

Although Claim 1 is not anticipated by Hutchinson, Applicant has amended the

claim to even further clarify these differences. An element has been added as a "*means for subjecting said object to modulated thermal excitation*", which more explicitly states what is mentioned in the "*means for subjecting...*". In addition the 'means for generating' element provides additional specificity that the signal is generated "*in response to changes in thermoreflectivity from a surface of said object arising while said object is subjected to said modulated thermal excitation*".

Therefore, as support does not exist for an anticipation rejection of Claim 1, Applicant respectfully requests that the rejection of Claim 1 and the claims which depend therefrom be withdrawn.

(b) Claim 2. Independent Claim 2 is drawn to apparatus claims having similar disclosure to Claim 1, but which are not written in a *"means-plus-function"* format.

In support of the rejection of independent Claim 2 the illumination source is discussed similarly as in Claim 1. However, support is lacking as Hutchinson requires a modulated illumination source, as described with respect to Claim 1.

In addition, Claim 2 recites that the "*object is subjected to modulated thermal excitation*", for which there is no support provided for the Hutchinson reference. Accordingly, Hutchinson does not anticipate Claim 2.

Applicant has amended Claim 2 to further recite the inclusion of "a circuit for modulating the thermal excitation of said object according to a known frequency", which denotes with greater particularity the aspect of modulated thermal excitation.

Support for an anticipation rejection requires that every claim element must be taught or inherent in a single prior art reference (MPEP) §706.02a. That condition is not met with regard to the support provided for the anticipation rejection of Claim 2.

Therefore, Claim 2 is not anticipated by the relied-upon reference, wherein Applicant respectfully requests that the rejection of Claim 2 and the claims which depend therefrom be withdrawn.

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(c) Claim 40. Independent Claim 40 recites a method for providing high resolution thermal imaging of an object being subjected to thermal modulation.

In support of the rejection of Claim 40 the same arguments and text from Hutchinson are put forth as for Claims 1 and 2 discussed above. However, as discussed within those claims, support is lacking.

Hutchinson requires modulating a light source for use in his measurements, this is not required per the description in Claim 40 of illuminating. Hutchinson does not provide for thermal imaging of an object "*subjected to thermal modulation*".

Applicant has amended Claim 40 to recite these aspects with greater particularity which further distinguishes over the Hutchinson reference. Specifically, the thermal modulation is "*at a known frequency range*", which allows the AC-coupled circuits to generate a signal "*in response to detected illumination associated with the known frequency of thermal modulation and thermoreflectivity changes of said object*". As Hutchinson uses neither thermal modulation nor changes in thermoreflectance it is lacking in support for an anticipation rejection of Claim 40.

Support for an anticipation rejection requires that every claim element must be taught or inherent in a single prior art reference (MPEP) §706.02a. That condition is not met with regard to Claim 40.

Therefore, Claim 40 is not anticipated by the relied-upon reference, wherein Applicant respectfully requests that the rejection of Claim 40 and the claims which depend therefrom be withdrawn.

(d) Claim 43. Independent Claim 43 is directed to a method of performing thermal object imaging.

Support for the rejection of Claim 43 follows the same reasoning and textual elements of Hutchinson as brought forth with regard to independent Claims 1, 2 and 40.

However, Hutchinson requires the use of a modulated light source, which is not

recited in this claim and has additional shortcomings with regard to Claim 43. Hutchinson is not configured, nor does it describe, thermally modulating an object when performing thermal imaging.

Claim 43 was also amended to recite certain aspects with greater particularity. In the amended claim the thermal modulation aspect is brought out with regard to detecting of the illumination, in that it is performed "*in response to changes in thermoreflectance of the surface as subjected to thermal modulation*". Again, these aspects are not taught by the Hutchinson reference.

Therefore, Claim 43 is not anticipated by the relied-upon reference, wherein Applicant respectfully requests that the rejection of Claim 43 and the claims which depend therefrom be withdrawn.

(e) Claims 3-12, 17, 19, 21, 23-26, and 42. Dependent Claims 3-12, 17, 19, 21, 23-26, and 42 within this group of claims depend from claims whose novelty has been discussed above. Accordingly these claims should be considered *a fortiori* allowable in view of the their dependency on the parent claims.

However, the discussion provided in support of the rejection on some of these dependent claims illustrate a misunderstanding of the claimed element, or misrepresentation of the cited reference. The following describes one such problem.

Claims 8-9. Dependent Claims 8-9 describes a "*means for generating a superresolution image from a combination of thermal images having a lower spatial resolution*". The rejection of Claims 8-9 misrepresent the principles of "superresolution", and pull elements from Hutchinson that do not relate to this feature. In particular, the Examiner contends that combining the two forms of emission form the superresolution, however, these optical signals are combined by Hutchinson to provide an IF according to heterodyne principles from which the image information is extracted.

By contrast, the specification of the instant application at pages 12 and 36

describe the use of superresolution within the invention. For example, *"increasing the resolution of the AC-coupled narrow band thermoreflection images captured from a sample under test, by constructing a high resolution image from a given set of low resolution images of the same scene. A fundamental requirement for the method is that relative motion exist between the scene and the camera, thereby realizing a form of optical synthetic aperture."* There is nothing within the Hutchinson reference which comports to this aspect.

4. Claims 1-31 and 40-44 are nonobvious.

Nor would the subject matter of Claims 1-31 and 40-44 be obvious to a person having ordinary skill in the art in view of Hutchinson, U.S. Patent No. 6,166,384 to Dentinger, U.S. Patent No. 5,199,054 to Adams, and/or U.S. Patent No. 6,288,381 to Messina, singly or in combination. None of the references cited by the Examiner, nor the combination thereof, suggests, teaches or provides motivation for modulated thermal excitation of an object, from which the reflection of a light source is detected for generating an AC-coupled bandwidth limited signal.

Therefore, since there is no need for modulated thermal excitation of the object, nor of the circuitry for registering the changes in thermoreflectivity of the surface from which a light is reflected within any of these references and, further, since there is no suggestion, teaching or motivation which can be found in these references from which a person having ordinary skill in the art would find it obvious to modify the thermal sensing of Hutchinson to correspond to that described in the Applicant's claims, Claims 1-31 and 40-44 recite structure which is patentable over the cited references for purposes of 35 U.S.C. § 103.

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5. Traversal of Rejection of Claim 1; In re Donaldson.

The Applicant respectfully traverses the grounds for rejection, and cites *In re Donaldson*, 16 F.3d 1189, 1193 (Fed. Cir. 1994)(en banc) as the basis for the traversal. Claim 1 is written in means plus function form pursuant to 35 U.S.C. §112, sixth paragraph, and therefore, must be interpreted during examination under *In re Donaldson*.

In rejecting Claim 1, as well as the claims that depend therefrom, the Examiner made no specific fact findings as to the scope of equivalents for the means plus function elements in the claims. Instead, the Examiner appears to have followed the provisions of MPEP § 2183 ("Making a Prima Facie Case of Equivalence"), which states:

> If the examiner finds that a prior art element performs the function specified in the claim, and is not excluded by any explicit definition provided in the specification for an equivalent, the examiner should infer from that finding that the prior art element is an equivalent, and should then conclude that the claimed limitation is anticipated by the prior art element. The burden then shifts to applicant to show that the element shown in the prior art is not an equivalent of the structure ... disclosed in the application. *In re Mulder*, 716 F.2d 1542, 219 U.S.P.Q. 189 (Fed. Cir. 1983). No further analysis of equivalents is required of the examiner until applicant disagrees with the examiner's conclusion, and provides reasons why the prior art element should not be considered an equivalent.

While the Examiner appears to have followed the provisions of MPEP §2183, such provisions are contrary to Federal Circuit law. The Federal Circuit has held that an examiner "construing means-plus-function language in a claim must look to the specification and interpret that language in light of the corresponding structure ... described therein, and equivalents thereof," *In re Donaldson*, 16 F.3d 1189, 1193 (Fed.

Cir. 1994)(en banc), and in so ruling expressly denied that "the PTO is exempt from this mandate." Id. The Federal Circuit added that it was specifically overruling any precedent that suggested or held to the contrary. Id. at 1193-94. In response to the PTO's argument that the court's ruling conflicted with the principle that a claim should be given its broadest reasonable interpretation during prosecution, the Federal Circuit held that the Donaldson decision was setting "a limit on how broadly the PTO may construe means-plus-function language under the rubric of 'reasonable interpretation.'" Id. at 1194. In other words, an examiner's claim interpretation is not "reasonable" if it is not based on the specification's description of the implementation of the means element of the claim. The court then said, "Accordingly, the PTO may not disregard the structure disclosed in the specification corresponding to such [means-plus-function] language when rendering a patentability determination. " Id. at 1195.

Here, as in *Donaldson*, the Examiner is required by statute to look to the Applicant's specification and construe the "means" language as referring to corresponding means disclosed in the specification and equivalents thereof." See id. at 1195. However, the Examiner did not construe the means language of these claims, however. Nor did the Examiner find, on the basis of specific facts of record here, that the means disclosed in the Applicant's specification were equivalent to that of the cited references. Instead, as prescribed by MPEP §§ 2183-84, the Examiner simply presumed equivalence. The presumption methodology used here, which the MPEP prescribes, clearly conflicts with the requirements of the Federal Circuit's Donaldson decision. The approach taken by the Examiner in this case also conflicts with *In re Bond*, 931 F.2d 831 (Fed. Cir. 1990).

The very point of these cases is that, in this context, limitations from the specification control the interpretation of the claim. Under §112, paragraph 6, a means-plus-function element of a claim must be construed to mean that which is disclosed in the specification and its equivalents. In *Donaldson*, the Federal Circuit said

that "our holding does not conflict with the general claim construction principle that limitations found only in the specification of a patent or patent application should not be imported or read into a claim." In other words, the court was saying that a §112, paragraph 6 "means" element does not need to be "imported or read into" a means-plus-function claim because the specification's limitations and their equivalents are already in the claim by virtue of §112, paragraph 6's command. Thus, the Federal Circuit said (16 F.3d at 1195): "What we are dealing with in this case is the construction of a limitation already in the claim in the form of a means-plus-function clause and a statutory mandate on how that clause must be construed."

Based on the foregoing, the Applicant respectfully submits that the rejection of Claim 1, as well as the claims that depend therefrom lacks proper foundation and that the rejection should be withdrawn. That claim which includes means plus function limitations, should have been interpreted in view of the specification as required by *In re Donaldson*. If those claims had been so interpreted, they would have been allowable since the cited references do not, singly or in combination, teach, suggest or provide motivation or incentive for the subject matter recited in those claims.

6. Amendment of Claims 1, 2, 6, 23, 26, 40, 43 and 44.

Claim 1. Independent Claim 1 was amended to recite that "*said means for generating a signal comprises an illumination detector*" to correct an antecedent basis issue with the original claim.

The element "*means for subjecting said object to modulated thermal excitation*" was incorporated, support for which is found in claims 2, 23, 26, 40 and 43 as well as throughout the specification, including page 16, line 19 through page 17, line 7.

The generating means was further defined with generating performed "*in response to changes in thermoreflectivity from a surface of said object arising while said object is subjected to said modulated thermal excitation*". Support for this aspect is recited in the specification, including page 16, line 21 through page 17, line 7; and page

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9, line 21 through page 10, line 3.

Claim 2. Independent Claim 2 was amended to recite the inclusion of "*a circuit for modulating the thermal excitation of said object at a known frequency*". Support for this aspect of the invention is described on page 9, lines 7-11; page 10, lines 12-14; page 24, lines 6-15; and page 47, lines 2-20. Support for the thermal excitation according to a "known frequency" is found on page 11, lines 1-2.

Claim 6. Dependent Claim 1 was amended to describe the AC-component aspect "*associated with a known frequency of said modulated thermal excitation*", support for which includes the specification on page 11, lines 1-2.

Claim 23. Dependent Claim 23 was amended to include a further description of the filter, "*said filter adapted with a passband associated with said thermal excitation*". Support for this aspect is found in the specification, such as at page 11, lines 3-7: "*A light, such as a laser is reflected from the surface of the sample whose reflection is registered by an AC-coupled imaging detector having a very narrow passband which is equal to, or associated with, the excitation frequency.*"

Claim 26. Dependent Claim 26 was amended to recite that the modulation is the *"thermal modulation"* as recited in other claims.

Claim 40. Independent Claim 40 was amended to include the description of the *"known frequency"* range of the thermal modulation and the use thereof. Support for this aspect is found in the specification, including page 10, lines 12-16.

Claim 43. Independent Claim 43 was amended to include the description of the *"known frequency"* range of the thermal modulation and the use thereof. Support for this aspect is found in the specification, including page 10, lines 12-16. In addition, Claim 43 was amended to recite the detection of reflected illumination is *"in response to changes in thermoreflectance of the surface as subjected to thermal modulation*". Support for this aspect is found in the other claims, as well as in the specification, such as on page 16, line 21 through page 17, line 7; and page 9, line 21 through page 10,

line 3.

Claim 44. Dependent Claim 44 was amended to recite that the modulation is *"thermal modulation"* as recited in other claims.

7. Amendments Made Without Prejudice or Estoppel.

Notwithstanding the amendments made and accompanying traversing remarks provided above, Applicant has made these amendments in order expedite allowance of the currently pending subject matter. However, Applicant does not acquiesce in the original grounds for rejection with respect to the original form of these claims. These amendments have been made without any prejudice, waiver, or estoppel, and without forfeiture or dedication to the public, with respect to the original subject matter of the claims as originally filed or in their form immediately preceding these amendments. Applicant reserves the right to pursue the original scope of these claims in the future, such as through continuation practice, for example.

8. Conclusion.

Based on the foregoing, Applicant respectfully requests that the various grounds for rejection in the Office Action be reconsidered and withdrawn with respect to the presently amended form of the claims, and that a Notice of Allowance be issued for the present application to pass to issuance.

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In the event any further matters remain at issue with respect to the present application, Applicants respectfully request that the Examiner please contact the undersigned below at the telephone number indicated in order to discuss such matter prior to the next action on the merits of this application.

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Respectfully submitted,

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